Temporal and spatial build-up of heavy metal contaminants in car parks

Tom A. Cochrane, Daniel Wicke, Aisling O'Sullivan

Dept. of Civil and Natural Resources Engineering
University of Canterbury, New Zealand
E-mail: *tom.cochrane@canterbury.ac.nz*

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

Purpose

An innovative experimental system was developed to quantify contaminant loads, determine their temporal and spatial variability, and obtain large data sets required for developing contaminant build-up and wash-off stormwater modeling functions for car parks.

Methodology

- **Thin asphalt / concrete boards constructed** — Size: 0.5 m² , 0.03 m deep; Materials: fine asphalt, coarse asphalt, and concrete
- **Boards exposed in car park (Fig. 1)** — Experiment A: Surface type; Experiment B: Wind effects; Experiment C: Build-up over time
- **Boards collected and placed under rainfall simulator** — 22 mm/hr intensity; 40-60 minute duration; Rainfall at pH of 6
- **Runoff collected** — @ 0, 5, 10, 20, 40, and 60 minutes; Variable sample volumes (0.3 to 1L for metals and TSS)
- **Samples analyzed** — TSS - lab analysis; Copper, Lead, Zinc – ICP-MS; pH, conductivity, turbidity, color
- **Build-up and wash-off functions developed (Table 1)** — Build-up: $B = \frac{B_{max} \cdot t}{A + t}$; Wash-off: $W = C_1 \cdot q \cdot B$

Fig 1a. Experiment A: surface type and vehicle traffic

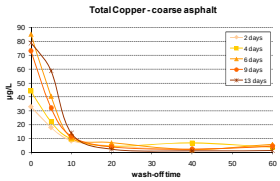
Fig 1d. Experimental site: Clyde car park University of Canterbury, New Zealand

Fig 1b. Experiment B: Wind effects

Fig 1c. Experiment C: Build-up over time

Contaminant Yield Results

- Most contaminants washed-off after 10 minutes @ 22 mm/h
- Steady increase in build-up over 6 days, variable there after
- Zinc most prevalent metal contaminant
- Differences between asphalt and concrete, but similar trends (Table 2)



Lead build-up and wash-off – asphalt

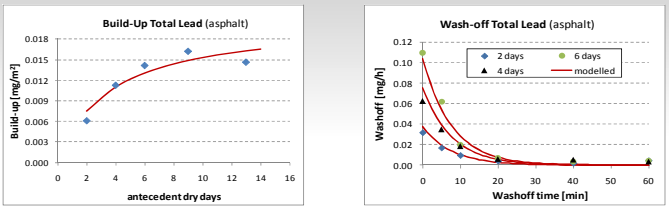


Table 1. Build-up and wash-off function parameters

	Concrete			Coarse Asphalt		
	Build-up		Wash-off	Build-up		Wash-off
	B_{max}	A	C_1	B_{max}	A	C_1
	mg/m²	[d]		mg/m²	[d]	
TSS	199	5.4	0.24	93	3.9	0.27
Total zinc	1.0	5.4	0.16	5.2	4.8	0.32
Total copper	0.25	3.2	0.09	0.15	2.4	0.34
Total lead	0.04	1.7	0.15	0.02	3.6	0.33

Table 2. Contaminant build-up over time (mg/m²)

	Concrete			Coarse Asphalt		
days	2	6	13	2	6	13
TSS	48	131	144	35	64	76
Total zinc	0.39	0.65	0.77	1.7	2.5	3.5
Total copper	0.12	0.19	0.20	0.07	0.13	0.13
Total lead	0.021	0.040	0.036	0.006	0.014	0.015

Conclusions

- Experimental method applied successfully
- Surface type influences contaminant build-up
- Wind distributes contaminants across car park
- Build-up and wash-off functions useful for modeling

Research group site: www.hydroeco.info